

scientific
communities
in the developing
world



EDITED BY
Jacques Gaillard
V V Krishna
Roland Waast

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Growing Pains: Brazilian Scientists and their Shifting Roles

Antonio Botelho and Simon Schwartzman*

For a short period of less than twenty years, between the late 1960s and early 1980s, Brazil developed an unparalleled effort to build its scientific and technological capabilities. This was supposed to make the country economically self-sufficient and develop a significant military presence in the world scenario. Such efforts could have hardly been predicted by Brazil's previous history of scientific and technological development, and the crisis which overtook the whole project since the mid-1980s came also as a surprise. How can one explain this short-lived experience, its origins and consequences? How did it affect the main actors in any effort of scientific and technological development, that is, the scientific community? This is the subject of this article.

The Golden Age

The ambitions of scientific and technological development in the 1970s can be seen as part of the 'great leap forward' attempted by the Brazilian military regime in those years, which included heavy investments in energy and infrastructure, the development of chemical and machine tools industries, the production of armaments and airplanes, and scientific and technological research in general terms. Some of these initiatives in the latter were:

- The university reform of 1968, with the partial adoption of the American system of graduate education and the re-organization of the universities in terms of institutes, departments and the credit system.
- The placement of S&T under the responsibility of the economic policy authorities, which allowed for a much higher influx of resources to S&T than ever before.
- The creation of a new federal agency for S&T under the Ministry of Planning—the 'Financiadora de Estudos e Projectos' (FINEP)—unencumbered by civil service routines and restrictions, and responsible for the administration of several hundred million dollars for S&T support.

- The establishment of a few large-scale centres for R&D, like the Coordenação dos Programas de Pós-Graduação em Engenharia (COPPE) of the Universidade Federal do Rio de Janeiro (UFRJ) and the Universidade de Campinas (UNICAMP), geared towards technological research and graduate education in engineering and science.
- The beginning of several programmes of military research, such as the space programme and the 'parallel' nuclear programme.
- The agreement with Germany for cooperation in nuclear energy, which was to create an autonomous capability in the construction of nuclear reactors based on locally re-processed fuel.
- The establishment of a policy of a protected market for the computer industry, and later micro-electronics, linked to an emerging national private sector.
- The formulation, by the federal government, of successive national plans for scientific and technological development.
- The establishment of centres for technological research under the main state-owned corporations, which sought to keep up with the technological frontier, develop standards and transfer technology to their main suppliers.
- The strengthening and formidable expansion of the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA—Brazilian Corporation for Agricultural Research), under the Ministry of Agriculture.

By the early 1980s, Brazil had about 10,000 to 15,000 active researchers publishing in the country and abroad, about 1,500 graduate programmes in all fields of knowledge, and a yearly budget for S&T of about US \$2 to 4 billion, amounting to between 0.6 and 0.8 per cent of the country's GNP. In 1992, Brazil ranked twentieth among nations indexed in scientific publications, trailing China, Belgium, Israel and Denmark, but ahead of Poland, Finland, Austria, Norway, Taiwan and Korea (Schott, 1993).

It is remarkable that only two decades earlier, when the military came to power in 1964, they entered in direct conflict with a substantial part of the country's intellectuals, including leading academics and scientists. As late as 1971, when some of the projects for scientific and technological development had been launched, dozens of professors and researchers of Brazil's main academic institutions were ousted from their positions, and in many cases they left the country. The military regime was perceived as conservative, submissive to international interests and conveniences, and hostile to the efforts to make Brazil a modern, rational and socially just country—ideals that mobilized most of the country's intellectuals, placing them in a collision course with the military government. To understand what happened in this short period, one should reconstruct the ideologies and motivations that shaped the behaviour and political mobilization of Brazilian scientists in the preceding years.

The Origins: The Roles of Modern Knowledge¹

Brazil, until the early nineteenth century, was a colony of Portugal, and because of that was twice remote from the scientific, technological and cultural revolution that swept Europe since the Renaissance. First, because Portugal itself remained a closed country, controlled by a conservative Catholic church, and shut off from the new ideas of religious reform, political liberalism and economic entrepreneurship. After its extraordinary maritime and colonial achievements in the fifteenth and sixteenth centuries, Portugal turned internally to traditional agriculture and became a client state of England, living off the inter-mediation of trade between Europe's more active economies and its colonies. Its largest colony, Brazil, was a source of valued goods in international trade (sugar, gold, wood) and its economy was based on slave labour, first the native 'Indians', and later Black Africans. For a long period, there was no significant European migration to the colony, except Portuguese government officers, tradesmen, persons receiving exceptional land grants and benefits, and Jews or 'New Christians' escaping from the Inquisition. While Spain tried to build its American empire over the pre-Colombian societies they found in America, populating the continent with universities and monasteries, the Portuguese destroyed or expelled the natives to remote regions and allowed only elementary education to be taught to the children of the richest families by the lower clergy.

This dismaying picture began to change early in the nineteenth century, when the Portuguese royal family was forced to come to Brazil under British protection fleeing from the encroachment of Napoleon. With the royal court came the first higher education institutions in law, military sciences and medicine, and later political independence, under the crown of descendants of the Portuguese royal family. Throughout the century, new higher education institutions were organized, the first museums of natural history were created, and the Brazilian emperor himself, Pedro II, was a Maecenas of the arts and sciences in Brazil and abroad. Brazil was one of the first nations to adopt the telephone. Slavery, however, persisted until 1888, together with a plantation economy and large areas populated by the remnants of the boom economies of sugar and gold of the preceding centuries.

It is difficult to talk about science in those years except for a few foreigners hired to manage the country's museums of natural history, the national observatory and, later, the geographical and geological commissions.² Their impact in the country was negligible and whatever the value of their scientific contributions, it was directed towards their colleagues and counterparts in Europe or eventually the United States. What Brazil did have, however, was the gradual emergence of a new social group—men educated in the liberal professions of law, medicine and engineering, some of them

educated abroad (Stols, 1974). More often than not, they would be the children of traditional families from regions with decaying economies, and would strive to regain status and prestige through the strength of the new knowledge granted to them by their education. For the medical doctors in the nineteenth century, Brazil was a sick country, suffering from lack of hygiene, promiscuous behaviour and bad eating habits. They felt the emerging medical profession should take the responsibility to clean the environment and control sexual and other appetites. Later, a small but significant elite in the medical profession became involved in large sanitation projects that were very effective in controlling some of the contagious diseases that ravaged the cities of Rio de Janeiro, São Paulo and Santos, and in the establishment of Brazil's first scientific institution—the Instituto Oswaldo Cruz—in Rio de Janeiro, inaugurated in 1900 (Stepan, 1976). For others, Brazil's main problem was related to the racial composition of its population. How could one not develop a modern, Western-style society, with a population dominated by Blacks, Indians and all kinds of mixed bloods? Theories about inferior and superior races entered the country and were avidly read and, in the first decades of this century, eugenics emerged as the magic key to the future and was the subject of books, voluntary associations and propaganda (Stepan, 1991). Races were already too mixed and the mores inherited from the Portuguese too permissive to allow for racial apartheid. Some theorists contended, however, that given the superiority of White blood, the Black and Indian races would slowly disappear in the country's melting pot, and the future was guaranteed by this slow whitening of the population. There were, however, tasks to be confronted at once. Criminality, drunkenness, stupidity—all these 'deformations' of character and personality were supposed to be hereditary and apparent in the shape of a person's head and body. To understand these links better, doctors turned to physical anthropology and legal medicine, which became the basis of Brazil's main tradition of anthropological studies. However, the eugenics movement was never strong enough to shape public policies, except perhaps for restrictions to the immigration of Orientals and Jews in the 1920s and 1930s, and after the War it lost all its legitimacy. It is not clear, however, how much of it remained in the perceptions of the country's elites.

For the military and engineers, positivism was the answer. Brazil was poor and underdeveloped because it lacked a government guided by science and concerned with the education of the poor. S&T for the positivists was very different from what was beginning to take place in research laboratories elsewhere—a gradual process of knowledge building through exchange of information, consolidation of experiences, negotiation and consensus building. It was first an ideology to settle professional turf disputes against priests, lawyers and others who did not have proper training in mathematics and the natural sciences. Followers of Auguste Comte created their own

religion, with their own 'temples' and 'saints'. Second, it was a re-enactment of the old Platonic notion of government by the philosopher. Knowledge was hierarchical, and those acquainted with its highest level—the new sociology proposed by Comte—were those entitled to rule. Positivists despised universities, perceived them as remnants of the old regime, and did not care about democracy and majority rule. Those who knew more had the right and the responsibility to govern—a task made easier when they were also military men with cannons on their side. The military overturned the Brazilian empire and the inauguration of the Republican period in 1889, and in the next century the military participated in several insurrections and coups d'état—in 1922, 1930, 1937, 1945, 1954, 1961 and 1964—always in the name of their superior training, knowledge and patriotic values.

Two related developments should be mentioned at this point—urban renewal and Marxism. In the late nineteenth century, the old capital of Minas Gerais Province, Ouro Preto, was replaced by a new city, Belo Horizonte, dreamed and planned by engineers, which was to be the beginnings of a new era of rationality and modernization for Brazil fit for the twentieth century (Bomeny, 1991). A few decades later, the old centre of Rio de Janeiro was razed to open the way for wide boulevards and modern buildings, after a period in which government agents entered people's houses searching for sources of mosquitoes and enforcing mandatory small-pox inoculations. In the early twentieth century, Rio de Janeiro witnessed one of the most curious episodes of the country's history—the rebellion against mandatory inoculation—with barricades being raised in the streets against the health authorities and wide support for the upraised population in the press (Murilo de Carvalho, 1987). What existed in common between the urban reformers and the sanitation authorities, and placed them against the urban poor and the newspapers, was the technocratic spirit with which they tried to force society to conform to their notions of health and urban aesthetics.

Socialist and revolutionary ideologies were brought to Brazil by Italians, Spaniards and Jews who landed in Rio de Janeiro at the turn of the century as part of the broad immigration wave that followed the end of slavery. They organized their burial associations, cooperatives and the first trade unions, and held the first strikes in the country's history. In the 1930s, however, the Brazilian Communist Party was taken over by a group of young military officers led by Luís Carlos Prestes, a former army captain, and in 1935 a series of rebellions in military barracks marked a failed attempt to install in Brazil a socialist regime with the active support of the International Communist Organization Comintern (Waack, 1993). In the following decades, this group of young officers remained the core of the Brazilian Communist Party, and it is difficult to tell them apart from their positivist colleagues, except for their alignment with the communist

movement. Like the positivists, they believed they had access to superior knowledge, Marxism, and the updated version of Comte's sociology. Their role was to spread the good news, educate the masses to let them see light, and take power by whatever means was available. Like the positivists, they did not care for research and scholarship, since all needed knowledge was already available, and of course had no appreciation for the rules of the democratic game, understood as a farce for the preservation of old oligarchies and the status quo. Were they to take power, they would place the whole economy under scientific management, end exploitation, provide education for everyone, and make Brazil a prosperous and happy country.

Varieties of modern knowledge, thus, helped to shape the ideologies of small, educated groups, coming usually from active or decaying elites, and which led to significant movements of social reform—on hindsight, some more pertinent, others completely misguided, but remaining always extremely elitist. Most of the founding fathers of twentieth century Brazilian science, both in the natural and biological sciences, came out of this ideological matrix.

The First Scientists and Academics

Brazil's first real university, the Universidade de São Paulo (USP), was inaugurated in 1934, and was the source of most of the research groups that emerged in other parts of the country after that. The creation of this university was the main outcome of a period of scientific and educational activism, when intellectuals, educators and some politicians mobilized to fight illiteracy and build higher education institutions of good quality. Brazil in the 1930s was still predominantly an agrarian society, but very different from the previous century. Massive migration, mainly from Europe and the Middle East, populated the rural areas and the main cities from Rio de Janeiro to the south; a small industrial base had begun to develop in the urban centres, producing food, textiles and other manufactures; while a booming coffee economy brought resources and attracted further migration to the state of São Paulo and neighbouring regions. Politically, the centralized empire of the nineteenth century had been replaced by a decentralized federation of states governed by local, rural-based oligarchies.

Developments in the areas of science and education should be seen in terms of at least three undercurrents that swept the country in those years. The first was the drive for political centralization, led by the military, the positivists and the intellectuals who saw in the authoritarian regimes of Europe the road to modernization and economic development. The second was the persistence of regionalism, which in some cases meant the maintenance of traditional patterns of oligarchical domination, but for the richest regions was related to the demands for autonomy for an active and

recent capitalist economy. The third was a drive for social mobility led by the second generation of immigrants and the educated children of the middle classes that lived around the main urban centres, and affected the previous two. In the end, modern Brazil was organized as a shifting balance between these tendencies, as illustrated in Table 12.1. Centralization occurred in 1930, but the autonomy of the more developed regions asserted itself through the years, while the middle classes gradually increased their size and presence in the country's affairs. The cleavage between centralization and decentralization trends appeared as a historical tension between the political elites in Rio de Janeiro and the business and economic elites in São Paulo.³

TABLE 12.1
Political Ideologies of Brazilian Elites

<i>Groups</i>	<i>Centralization Trends</i>	<i>Decentralization Trends</i>
Elites	Autocratic Policies Technocratic Ideologies	Oligarchic Domination Liberal Ideologies
New Middle Sectors	Populist Policies Authoritarian Ideologies	Participatory Politics Social Democratic Ideologies

The movements for science and education in the 1930s were mostly an affair of the elites, and incorporated little of the demands and values of the middle and lower sections of society. In Rio de Janeiro, an ambitious project of a national university hoped to set the standard and the model for the country. Architects from Fascist Italy were invited to plan for a university city, select working groups, meet to define the contents of courses in all areas of knowledge under strict government supervision, and from then on a uniform, coherent educational structure was to evolve.⁴ The Second World War and the climate of political democratization that ensued from Brazil's decision to join the allies in the War effort emptied this project of its more authoritarian contents, but this was still the origin of the Universidade do Brazil in Rio de Janeiro (now the UFRJ).

The USP was also a creation of the state's business and political elites, but it was altogether different. There was an explicit intention to form and educate a regional elite which could confront and overcome the autocrats in Rio de Janeiro and the traditional politicians in other states. The new university was to be organized around a group of European scientists invited to form a new Faculty of Philosophy, Science and Letters, which was supposed to provide scientific support to the professional faculties and to educate teachers for secondary schools. Professors were invited because of their academic credentials and, of course, their willingness to come to Brazil in those years. Governments of France and Italy were willing to help

in a dispute to establish their influence in the new university. Several dozen professors came, and some remained in Brazil for the rest of their lives.⁵

In a small scale, USP opened the space for a new kind of scientist that did not exist before in Brazil—academic men and women getting prestige and acknowledgement for their efforts and talent, and not from their class of origin or political ambitions. In part, this was because several of the invited professors, and most of those who remained, were relatively young and marginal in their own societies (in many cases Jews fleeing from prejudice and discrimination). In Brazil, they looked for disciples, and found them among the children of immigrants and the growing middle classes. For the first time in Brazil, at USP, women entered academic careers in the natural and social sciences in significant numbers. There was a clear contrast between the perceived roles and social behaviour of academics and intellectuals in the country's two centres, which has been observed in detail for the social sciences but was probably present in other fields of knowledge as well (Miceli, 1989). In the capital Rio, intellectuals sought to produce broad interpretations of the country's history and culture, write for the larger public and maintain an active political role (made easier by their closeness to the restricted circles of the political elite). They were not necessarily less ambitious in São Paulo, but their conditions were different. Power was further away, their social origins did not help, they had a better university to work on, and a much larger pool of students and disciples willing to follow their steps. Thus, they had the chance to develop academic careers and, when they got involved in politics, they often acted more as representatives from the rising social movements than from the regional elites.

Political Activism and the 'Americanization' of Brazilian S&T: The Post-War Years

We can summarize the preceding discussion by saying that from the nineteenth century onwards Brazilian intellectuals, academics and scientists often shared the Platonic view of their destiny as the saviours of their country through their special and privileged talent and knowledge. As the liberal professions of medicine, engineering and law became larger and more established, they also became more professional, taking care of their special place and privileges in society but slowly abandoning the higher ambitions of dominant power and influence. Scientists, as a smaller late-comer group, may have followed a similar pattern, although at a later time.

The small group of scientists and researchers educated at USP, working in the basic sciences and in the institutes of tropical medicine, agricultural research and a few other locations until the 1930s, got a significant boost in

their standing and working conditions after the Second World War. Brazil was persuaded by the American government to join the allies in the War effort, and now it was time to help Brazil to overcome its problem of underdevelopment and backwardness. Brazil's first steel plant, in Volta Redonda near Rio de Janeiro, was built with American support as part of the understanding that led Brazil into the War. During the War years, the Rockefeller Foundation, which had participated for years in the control of tropical diseases in Brazil, started providing leading Brazilian physicists and biologists with fellowships to study in the United States.⁶ At the end of Dutra's presidency (1945–1950), Brazil negotiated a plan for economic development with the American government that led to a growing institutional influence of American S&T in Brazil. A centre for education and research in aeronautics was developed in the São José dos Campos, under the coordination of Brazil's air force ministry and in cooperation with American engineers and technicians, which gave rise to the Instituto Tecnológico da Aeronáutica (ITA) and the Centro Tecnológico da Aeronáutica (CTA). Both institutions would play a central role in the development of Brazilian S&T over the following decade.⁷ Moreover, ITA renewed the stagnant state of engineering teaching in the country by emphasizing its scientific and research components. In the process, it spawned a new community of engineering researchers who would compete with the more academic scientific community for professional legitimacy and for defining the content and direction of Brazilian research in the decades ahead.

In the mid-1950s, Brazilian war surpluses had vanished, and populist politics reduced the federal and local governments' willingness to support science, while the intensity of American cooperation diminished because of the new priorities of the Cold War. Scientists of all persuasions felt a direct threat to their working conditions, and for the first time got organized in an independent association for self-protection—the Brazilian Association for the Advancement of Sciences (SBPC) (see Botelho, 1990a and b; Fernandes, 1989). SBPC was instrumental in the organization of Brazilian scientists as a pressure group; in intensifying its links with the international scientific community; and in the organization of the National Research Council, moulded on the American National Science Foundation, which was supposed to provide the backbone for Brazil's nuclear programme and became Brazil's main science support agency.

The Americanization of Brazilian S&T caused several fractures in the budding Brazilian scientific community. The Americans were willing to help, but not to meet the more ambitious pretensions of their Brazilian allies and would not let them develop an autonomous nuclear capability. In the early 1950s, a group of high ranking military officers and physicists developed a project to provide Brazil with the complete cycle of nuclear energy production, which would also allow for the development of nuclear weapons. The National Research Council and the Brazilian Centre for Physics Research (CBPF) were organized as part of this strategy. The

nuclear project was vetoed by the United States, which eventually convinced Brazil to buy a Westinghouse nuclear power plant fuelled with enriched uranium to be supplied by the US (see Goldenberg, 1978; Cabral, 1986; Goldman, 1986; Adler, 1987). In the following years, Brazilian scientists and intellectuals split between those engaged in the American-led modernization trend and those that resented the limitations placed by this alliance on the country's ambitions for independence and economic growth. Anti-Americanism appeared both as nationalism and as anti-capitalism, and the history of Brazil's Marxism contributed to keeping them blurred.

Brazil experienced a period of rapid industrialization during President Juscelino Kubitschek's administration (1955–1960), creating a sudden demand for modern engineering expertise. Modern engineering professionals seized the opportunity to create new institutions and legitimate themselves, which increasingly pitted them against a fragile scientific community. Professional and institutional turf battles took place throughout the late 1950s and early 1960s. Furthermore, ideological battles crisscrossed both communities of researchers and practitioners. The relative success of Kubitschek's industrialization programme strengthened the power of the engineering community, which also found important allies in the growing economic policy making community and in the increasingly discontent military sector. Brazil's alignment with the United States in the Cold War did not solve its problems of underdevelopment and, in the increasingly polarized climate of the late 1950s and early 1960s, scientists and intellectuals spoke out for the modernization of Brazil's universities, the increase in public support for scientific research, and the evils of the alliance between the country's elites and American economic and military interests. When the moment of confrontation came in 1964, the lines were already drawn and the conflict was unavoidable.

Political Authoritarianism and Scientific Growth

The conflict between the Brazilian military government and the academic community began at the onset of the military regime in 1964, with arrests of academics and scientists and interventions in some universities. The Universidade de Brasília (UnB), created a few years earlier as the emblematic institution of the social modernization movement, was particularly hit. As an organization, it followed closely the American model of a research university, organized in departments and with a strong scientific component. Ideologically, it was supposed to represent the Brazil of the future, with scientists and academics leading a growing national awareness of the country's social and economic needs and leading the nation towards self-sufficiency and social justice. Repression reached its climax in 1971, when several among the best known Brazilian scientists went into forced or voluntary exile.

This was, however, just one face of an ever contradictory picture. The 1968 university reform legislation generalized graduate education and the department structure in public universities, ending with a French-based tradition of professional chairs considered by the scientists as a central roadblock to the modernization of the universities. The National Bank for Economic Development (BNDE), Brazil's main development bank, created a fund for technological projects in 1968, and a few years later the Ministry of Planning set up FINEP, the main agency for science support for the next decades and started to negotiate the return of some of Brazil's leading scientists to the country. UNICAMP, which would become one of Brazil's leading research universities, was organized in the early 1970s around groups of returning scientists and engineers. In physics, for example, its basis was a small group of physicists then working at Bell Laboratories who were persuaded to come back with the promise of strong support for applied research. An equally ambitious project was the organization of the engineering graduate programme at COPPE in Rio de Janeiro.* In 1972, an international comparative survey on education abroad and brain drain showed that Brazil was one of the leading countries in the developing world in its ability to bring back and maintain the students it sent out for graduate education (Glaser, 1978). At the end of the decade, most of the prominent scientists who had left the country in the previous years had returned and had often been reinstated in their previous posts.

An explanation for this apparent contradiction is that ideological radicalization was limited to a faction of the military on the right and to a section of the scientists and academics on the left. Anti-communism and anti-intellectualism were important ideological components of Brazil's military regime, and in the early 1970s they were used to justify the power and influence of the so-called 'intelligence community' of the military involved directly with the repression of urban guerrillas. Their influence in other sectors of government was, however, limited. They had little influence on matters of economic policy, for instance, and in the fields of science and education their role was limited to blacklisting the most outspoken figures of the opposition of eventual benefits and nominations to administrative positions.

For most scientists, the sudden availability of research money and employment opportunities, and the modernity and efficiency of the new S&T agencies and their officers (usually young economists or persons with scientific and technological backgrounds), was enough to dispel the notion that the regime was thoroughly anti-intellectual and anti-scientific. The scientific community had a role to play, which was different from what some of them had imagined in the previous years, but it was important all the same, and they took to it with eagerness. Throughout the military regime, the Brazilian Society for the Advancement of Science continued to castigate the government for its authoritarian policies, and its annual meetings were important occasions when suppressed groups could speak out against the

regime under the spotlight of the press. It is indeed telling that these meetings were mostly paid for with government grants and, except on one or two occasions, the government did not attempt to suppress them (Botelho, 1990a).

The main difference between the new and the old roles of the scientific community was the narrow limits of the new situation. In the past, many scientists and intellectuals perceived themselves as leaders of broad social revolutionary movements. The campaigns for university reforms in the 1950s and 1960s were a good illustration of that. The universities were elitist, traditional professions controlled the chairs, they were unconcerned with criticism, not committed to providing solutions to the country's main problems, unable to incorporate modern science, had access limited to the children of the upper classes and were isolated politically. A revolution was needed. It would put scientists at the centre of new institutions, the university gates would be open to all, and political alliances would allow professors and students to work together for the solution of the country's problems. In the 1970s, this view had almost vanished and was replaced by a professional pragmatism tinted with nationalism. The top-down university reform of 1968 was surprisingly close to the demands of the past, but it brought to light the contradictions and tensions which existed unavoidably between mass- and research-based higher education. The political climate did not allow for scientists to keep links with organized political movements, and their opposition to the government would have jeopardized the scientists' recently acquired access to public funds and institutional posts. Thus, political activism was replaced by pragmatism. In their newly perceived roles, the scientists were supposed to modernize the state and the economy, to increase the productivity of industry and agriculture, and build a strong institutional and professional basis for themselves. The military, eventually, would go away, and their role in transforming and modernizing society would become obvious to all. The legacy of the 1950s was however expressed in the technological nationalism that flared up in a few technological projects in the 1970s: computers, micro-electronics, space, airplanes and telecommunications. It served as a mythical element that forged a bridge between the old and the new generation of scientists and technologists, and gave the emerging new community a heroic identity above and beyond its pragmatic aspirations.

Technological Nationalism and Retrenchment (After 1978)

Alas, *l'age d'or* of scientific and technological development did not last long. From the beginning, there was a tension between the country's economic policies, geared to increasing trade and the attraction of foreign firms and capital to Brazil, and the drive for self-sufficiency and nationalism which was present in a segment of the technological community, both

civilian and military. While the economy kept growing, this tension could be accommodated. Already by the mid-1970s, barely a year after the first oil crisis, there were signs of decline in the funding of scientific research. At the end of the decade, external debt ran out of control, inflation intensified and expenditures on S&T which had continued to grow in the second half of the 1970s in the politically stronger mission-oriented state research institutions such as the Airforce Technological Centre (CTA), National Space Research Institute (INPE), National Council of Nuclear Research (CNEN), Brazilian Company for Agricultural Research (EMB-RAPA), the Research Centre of Petrobrás (CENPES), Research Centre of Electrobrás (CEPEL) and the R&D Centre of Telebrás (CpqD) in detriment to the broader academic establishment started to be perceived by the economic authorities as a waste of resources. There was also a noticeable shift in the destination of resources towards technological research (Botelho, 1993). The crisis that was gradually growing only got worse after 1985, when the military handed over political power to a civilian government. By then, a closed political system had given way to an over politicized society, where a myriad of scattered interest groups jostled for the spoils of a decadent state and a stagnant economy. The ideal environmental conditions for the emergence of a corporative reaction were all in place: dwindling resources, fragmented leading institutions, administrative instability and competition, lack of a unifying vision and a political vacuum. The direct consequences of this situation were the drastic reduction of resources for S&T and a general feeling of demoralization in the scientific and technological communities. The reaction from the scientific community consisted of an attempt to re-enact two roles of the past—one of the scientist as the leader of economic and political nationalism and the other as a social vanguard.

The best expression of nationalism was the expansion and intensification of the policy of market reserve for the computer industry, which came to include micro-electronics and telecommunications, although it was by no means alone (other examples were the nuclear, space and arms producing programmes). The computer policy brought together the conservative military, the liberal scientists and engineers in a joint effort to build a national computer industry that could resist the invasion of multinational corporations and their proprietary equipment.⁹ This alliance proved strong enough to pass a comprehensive law approved by Congress and signed by the last military president in the twilight of his government. The law remained in effect until the early 1990s, but failed to create a critical infrastructure for R&D in computer science and micro-electronics that was to be the backbone of the new policy. It eventually suffered the opposition of economic policy makers and most user groups, from academics to industrialists who were restricted in their ability to get access to state-of-the-art information technologies.

The second role consisted of the organization of scientists, researchers and university professors as interest groups and lobbies concerned with the defence of their special interests. Even the SBPC, which in the past had always combined a public image with a prestigious scientific leadership and a permanent dialogue with the government authorities, strengthened its ties with the syndicates of university professors and civil servants and committed itself to the defence of technological nationalism, which included the remnants of the computer policy, the support for military projects and opposition to the enactment of an internationally accepted patents law. At the professional and institutional levels, corporative organizations engulfed each other in a continuing battle for scarce resources, political visibility and social legitimacy. The professional and political constitutive elements of the identity of the scientific community of the 1970s were shattered.

The Future

The future of the Brazilian scientific community will partly depend on the country's ability to start over its drive for social modernization and economic development, under the new conditions of the 1990s and after the year AD 2000, and to establish a new identity. After a decade of economic instability, stagnation and high inflation, there is an ongoing discussion about what these new conditions are and what will be needed to respond to them. This discussion will necessarily affect the whole sector of science, technology and education, and influence the attitudes and perceptions of scientists and academics. We can summarize our perspective about the future in three propositions.

First, the motivations, perceptions and mechanisms that had characterized 'the golden age' of the 1970s and which had lingered through the 1980s will not return for several reasons. The growing internationalization of the economy is increasingly incompatible with policies of technological and economic self-sufficiency, and the new international order derived from the end of the Cold War does not justify a concentration of scientific and technological investments in a limited number of military projects. As military security is redefined as economic security, the rationale, methodology and limits for state intervention will change.

Second, it has been realized that a central requirement of a modern economy is an educated population and the spreading of professional, managerial and technical competence throughout society. Brazilian higher education and technical training have been traditionally limited to a small elite, and scientists and technologists have been traditionally more inclined to work at the top—with sophisticated technologies, advanced equipment and high concentration of resources—than at the base of society. This elitism of the scientific and intellectual groups is the counterpart of the

country's elitist social culture, and it will not go away easily. Scientists, technologists and academics will continue to lose legitimacy and social support if they do not strive to place their knowledge and competence in the service of society as a whole. The isolation of traditional scientific and academic institutions created opportunities for the emergence of alternate institutions more in tune with local and sectoral realities. Out of 900 higher education institutions in Brazil, 690 are now private institutions. While the quality of education in these establishments is generally low and little research is carried out in them, the unfolding political economy environment may create the right conditions and incentives for them to flourish in new directions.

Third, it is not likely that the government will continue to subsidize academic research and ambitious technological projects if they do not incorporate a well-defined educational, economic or social component. However, as widespread political instability remains, the simple repackaging of old wine in new bottles will continue to be immensely attractive to populist politicians linked to corporative organizations.

Finally, the Brazilian institutional and political framework for S&T development underwent great transformations in the intervening decade. It became far more complex, regionally-oriented and institutionally segmented. At the political level, the traditional financing agencies have largely succumbed to unwieldy bureaucratization and lack of vision. Technocratic efforts to correct this situation through greater centralization and research targeting are blind to the emerging decentralized characteristics of the system and are thus doomed to failure. The mixed results, at best, of the World Bank programmes over the past decade are a testimony to that. Professional segments of the scientific community, in a last corporative gasp to regain an old-fashioned political legitimacy, are betting on big science projects, unaware of the growing mismatch of big science to the international political economy of science and to the domestic societal expectations of the 1990s.

If these propositions are true, then they mean that Brazilian society will still have an important role for its scientists and technologists in the future, but it will be very different from what it has been so far. They would have to definitely give up their Platonic ambition, or the pretence of leading society in the name of their special competence, and become a *primus inter pares* group participating in the reconstruction of new societal projects. They must learn to work in a more cooperative and negotiated context, which will however be more competitive scientifically and stricter in the evaluation of the social costs and benefits of scientific and academic enterprise. They must create new and more flexible links with other sectors of society, and look for resources, support and markets for their services in places beyond the state and large international agencies. It will be a

difficult transition, but not an impossible one, and, at the end, the role of the scientific community in the country would be much more in tune with society's needs and aspirations and more legitimized than it has been so far.

The seeds of this transformation are currently budding: vibrant regional S&T networks; the steady growth of R&D in private firms and university-industry truly cooperative projects; a larger diversity of financial support sources; and innovative international and local paths for institution-building. The question remains whether this new system can grow and flower, as the obstacles ahead are multiple. The rapid deterioration of the instrumental and political capacities of the Brazilian state, and the slow and uneven maturing of alternate institutional arrangements at the local level may create a dangerous intermediate situation. Foreign agencies' and federal government experts' visions shaped in a rapidly disappearing era may act as shutters, blocking them from recognizing and priming these promising changes. Continued political and economic instability has created a disenchantment among the new generation of researchers and technologists, who may become reluctant to pursue a new vision for the organization and development of S&T in Brazil. In the end, there is little doubt that the emerging Brazilian scientific community in the 1990s will be more worldly and decentralized, thanks partly to the diffusion of new communication technologies, and more regionally-oriented than its predecessor of the 1970s and 1980s. The demise of the dual hegemony of the central government and of the São Paulo-Rio de Janeiro institutional axis over Brazilian S&T will unleash new and unforeseen tensions, which will ultimately shape the community in the 1990s and beyond.

Notes

* Alphabetical order.

1. Part of the analysis in this section is drawn from Schwartzman (1991a).
2. For an overview of Brazilian science since the nineteenth century, see Schwartzman (1991b).
3. For a political analysis of this process of social transformation see Schwartzman (1981).
4. For details see Schwartzman (1991b).
5. On the nature and impact of the French contingent see Petitjean (1992). An exploratory account of the German and German-Jew contingents is in Plonski and Plonski (1992).
6. The Rockefeller Foundation had been involved in the development of Brazilian health programmes and medical science since 1917 (see Cueto, 1994).
7. About the creation of ITA, see Botelho (1991). For an analysis of the economic impact of MIT, see Dagnino and Proença (1989).
8. For the creation of UNICAMP and COPPE, see Schwartzman (1991b).
9. There is vast literature on the Brazilian computer policy (see, among others, Botelho, 1987; Evans, 1986; Tigre, 1983; Botelho and Smith, 1985).

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